Penny Drop Lab

Grant Perkins, Section H
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Lab Partners: S. Amin, B. Heggadahalli

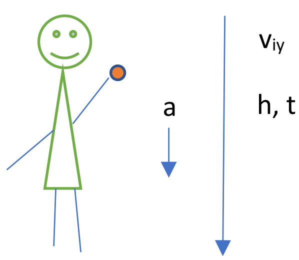
Introduction

The purpose of this lab was to design an experiment using a penny and a stopwatch to determine the acceleration of gravity based on the curve of best fit from the graphed data. The question was: how does increasing the vertical distance from a penny is dropped affect the time it takes for the penny to fall on the surface? It was hypothesized that as the height at which a penny is dropped increases, the time it takes to fall is proportional where $t \propto \sqrt{h}$.

Procedure and Materials

First, Grant placed the measuring tape against the wall and Bharath placed tape on the wall marking six different drop heights. Repeating ten times at each drop height, the following occurred: Bharath said “3, 2, 1 go,” and started the timer as he said “go”, Grant dropped the penny holding it vertically when he heard the word “go”, Bharath stopped the timer when he saw that the penny hit the ground, and he told Suhani the time he read on the stopwatch, and she recorded the time.

Diagram



Constants and Equations

$m_p = 2.53$ g
$v_{iy} = 0$ m/s
$y_i = h$
$y_f = 0$ m
$a_T = -9.8$ m/s^2

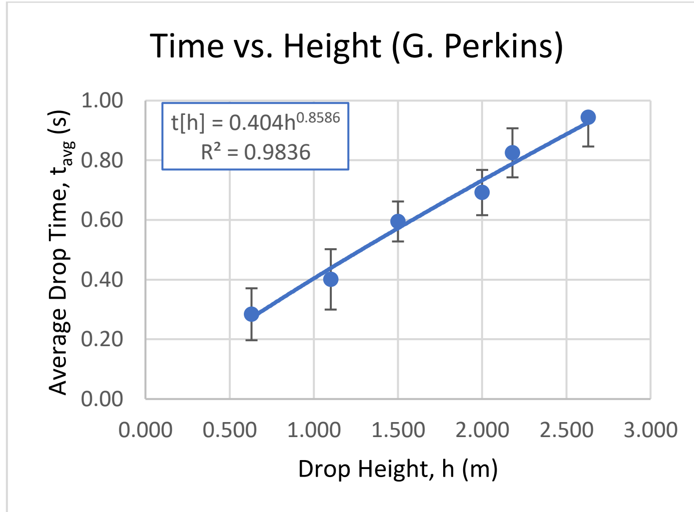
$$y_f = \tfrac{1}{2}at^2 + v_{iy}t + y_i$$

$$t_T[h] = \sqrt{\frac{-2h}{a_T}}$$

Data Summary

h (m)	t_{avg} (s)	SD (s)	%RSD of t_{avg}	t_T (s)	|%err| of t
0.630	0.28	0.09	30.66	0.36	20.80
1.100	0.40	0.10	25.23	0.47	15.37
1.500	0.60	0.07	11.27	0.55	7.54
2.000	0.69	0.08	10.96	0.64	8.32
2.180	0.83	0.08	9.97	0.67	23.69
2.630	0.94	0.10	10.36	0.73	28.85
		Avg	16.41	Avg	17.43

Graph



Analysis

Using the formula found in Constants and Equations, the calculated acceleration of the data in was -4.89 m/s^2. This value was nearly half of the theoretical -9.8 m/s^2. The data had a %RSD of 16.41%, meaning that the data had low precision. The |%err| of 17.43 means that the data also had low accuracy. The R^2 value of .9836 means that the model is very strong, however. The y intercept of zero agrees with the fact that at 0 m, the penny will take 0 s to fall. The slope has no literal meaning, however because it is in s^2/m, it can be used to find the experimental acceleration. Limits of the data is that the height and drop time must be greater than zero, because the penny must fall to be timed and drop times cannot be negative or zero. The graph has no maximum, because the model does not account for terminal velocity.

Conclusions

The data supports the hypothesis that as the height at which a penny is dropped increases, the time it takes to fall is proportional where $t \propto \sqrt{h}$. One source of error could be the method of recording time. Human reflexes impacted when the timer was started, when the penny was dropped, and when the timer was stopped. This latency very likely effected the data in this experiment, causing the slower than expected acceleration. Future experiments should have methods which include fewer human elements. This could be done with automatic timers which start when the penny has passed a laser at the drop height and end when the penny touches a sensor on the ground. Future experiments could also explore dropping the penny with different initial velocities